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G2J JMH JMC

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(56) Documents cited

US 4660941 A

US 4425026 A

US 4408832 A

US 4239343 A

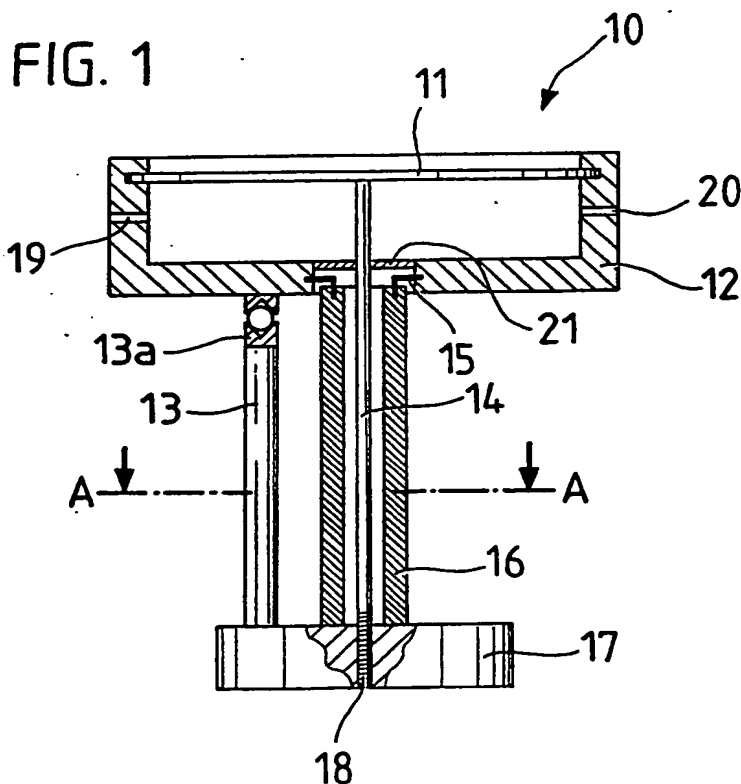
(58) Field of search

UK CL (Edition K) G2J JB7F JMH

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(54) Tilttable deformable mirror

(57) A device for angle and focus correction of a laser beam using a deformable mirror 10 insertable into beam path, comprises a mirror housing 12 supported by piezo-electric control elements 13 mounted on a base 17 for effecting tilting of the housing 12, the deformable mirror 10 having a pull rod 14 adjustably mounted to the base 17 for adjusting curvature of the mirror 11 e.g. by micrometer thread 18. The mirror may be cooled and coolant may pass through inlet 19 and outlet 20.



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FIG. 1

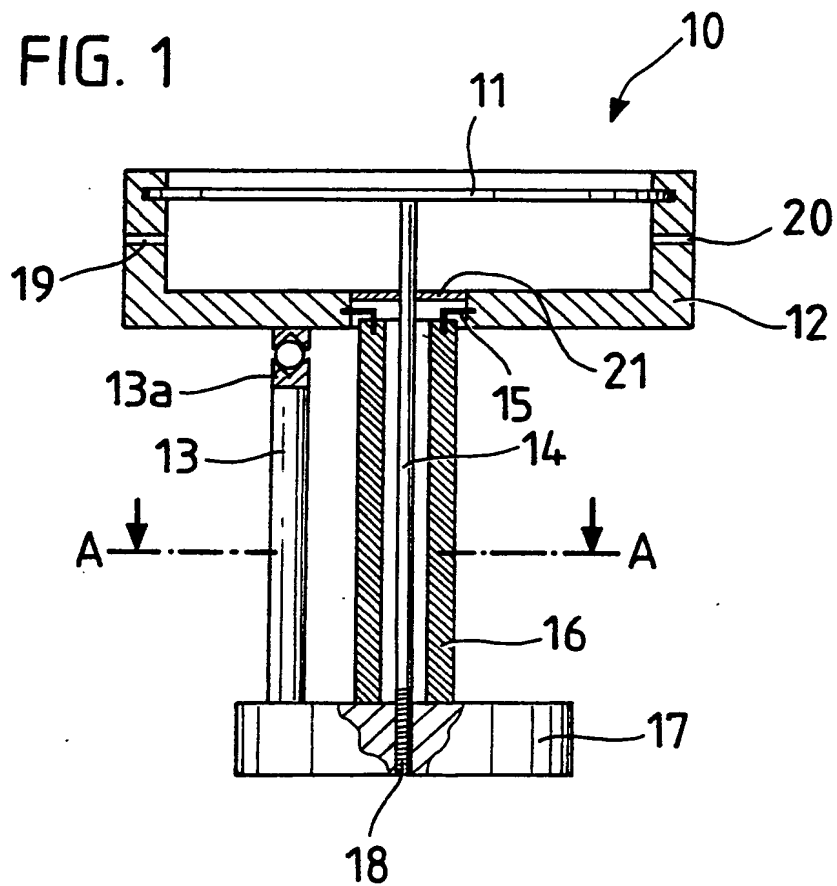
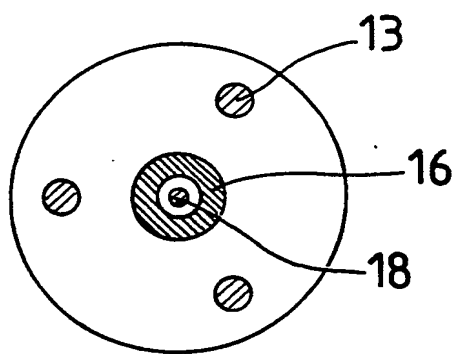


FIG. 2



DEVICE FOR ANGLE AND FOCUS CORRECTION

The present invention relates to a device for angle and focus correction for insertion into beam path of a laser.

Devices of this general type are already known. They are used in particular for the beam control of high-output lasers for material processing. An exemplary embodiment of this is shown, for example, by the applicants in DE-PS 32 02 432. However, difficulties arise in the production, assembly and alignment of such devices, as many individual components have to be operationally connected and alignment is relatively complicated.

Also, DE-PS 34 22 232 C2 discloses a device for aim-search and aim lock-on according to the above general type. Again, in such an arrangement, difficulties arise in the production, assembly, and alignment of the components. DE-OS 30 36 083 A1, of the present applicant, also discloses a mirror with adjustable or variable curvature, in which a mounting element, which is connected to a mirror surface and a housing body, produces or adjusts the curvature. However, this form of device has limited control possibilities, for example as regards tilting. Also DE-AS 27 57 585 B2 describes a device for automatic alignment of a laserbeam towards a target, using piezo-electrical control members for tilting a mirror and finally US-PS 4 674 848 discloses a deformable mirror with a cooling system. Again, this form of embodiment is also extremely elaborate as regards the construction elements, manufacture and assembly.

It is an object of the present invention to provide a device of the aforementioned general type, which may be constructed as one single adaptive component, which may be not only reliably and unitarily controlled, but which is comparatively simplified in construction and which may have improved possibilities of adjustment.

According to an aspect of the present invention there is provided a device for angle and focus correction of a laser beam using a deformable mirror insertable into beam path, which device comprises a mirror housing supported by piezo electric control elements mounted on a base for effecting tilting of the housing, the deformable mirror having a pull rod adjustably mounted to the base for adjusting curvature of the mirror.

According to an embodiment of the invention there is provided a device for angle and focus correction of a laser beam using a deformable mirror insertable into beam path, which device comprises a cylindrical mirror housing supported by way of rotationally symmetrical bending means on a support tube mounted on a base, the housing also being supported by annularly spaced piezo-electric control elements mounted on said base for effecting tilting of the housing, the deformable mirror having a pull rod passing through the support tube adjustably mounted to the base for adjusting curvature of the mirror.

An embodiment of the invention will now be more specifically described with reference to the accompanying drawings in which;

Fig. 1 is a schematic illustration of a longitudinal section of an adaptive or adjustable mirror;

Fig. 2 is a cross-section along the line A-A of Fig. 1.

Fig. 1 illustrates an exemplary embodiment of an adjustable mirror, for insertion into the beam path of a laser as a single, complete component, for influencing the angle and divergence of the laser beam thereat. To achieve this, the mirror surface can be both tilted in various directions and spherically deformed.

The adjustable mirror 10 comprises a mirror diaphragm 11, the edge of which is clamped in a groove, or by another construction method, into a cylindrical mirror housing portion 12, and on a support tube 16, which is mounted on a base plate 17. The cylindrical housing portion 12 is connected to the cylindrical support tube 16 via a rotationally-symmetrical bending element 15 and is supported on three piezo-electric ceramic control elements 13.

The mirror diaphragm 11 is connected to the base plate 17 via a pull rod 14 which has a micrometer thread 18 at its end near the base, so that curvature of the mirror diaphragm 11 can be adjusted and set by the micrometer thread 18 of the pull rod 14 acting on one side of the mirror which is clamped at its edges to the housing portion 12. Also, a respective operational curvature is established by equal setting of the piezo-ceramic control elements 13 of the mirror diaphragm 11. If the mirror diaphragm is now to be additionally tilted in a defined manner relative to the X or Y axis, then the individual control elements 13 are directed accordingly.

As is shown in Fig. 2, these control elements 13 are annularly mounted on the base plate 17 and engage the outside base surface of the cylindrical housing portion 12 with their piezo-ceramic elements 13a. These piezo-ceramic control elements 13, 13a are only held under pressure and the force or action of the piezo-control elements in the longitudinal direction to effect tilting and specified curvature can be altered to a maximum value by varying their distance from the centre axis.

Cooling of the mirror diaphragm is relatively straightforward. The central bore of the cylindrical housing portion 12 is sealed by a seal 21. A cooling-medium inlet or feed element 19 is arranged at a certain height relative to the mirror support in the housing case and an outlet or drain element 20 is arranged opposite the inlet. Feed of the

cooling-medium is regulated so that the cooling-medium pressure does not impede or affect the set curvature of the mirror diaphragm 11.

CLAIMS

1. A device for angle and focus correction of a laser beam using a deformable mirror insertable into beam path, which device comprises a mirror housing supported by piezo electric control elements mounted on a base for effecting tilting of the housing, the deformable mirror having a pull rod adjustably mounted to the base for adjusting curvature of the mirror.
2. A device according to claim 1 having a cylindrical mirror housing.
3. A device according to claim 1 or 2 wherein the mirror housing is also supported by way of rotationally symmetrical bending means on a support tube mounted on the base.
4. A device according to any preceding claim wherein the piezo electric control elements are annularly spaced.
5. A device according to claim 4, having three equally spaced piezo-electric control elements.
6. A device according to any preceding claim, wherein the pull rod is mounted to the base through a micrometer screw thread.
7. A device according to any preceding claim, wherein the housing is sealed around the pull rod and has an inlet and an outlet for cooling medium to assist virtually pressureless cooling.
8. A device according to any preceding claim, wherein the control elements are adjustably mounted on the base or are provided with adjustable control members for tilting the mirror housing into predetermined positions.

9. A device substantially as hereinbefore described with reference to the accompanying drawings.

**Patents Act 1977**  
**Examiner's report to the Comptroller under**  
**Section 17 (The Search Report)**

Application number  
91 324.3

<b>Relevant Technical fields</b>  (i) UK Cl (Edition K ) G2J (JMH, JB7F)  (ii) Int Cl (Edition 5 ) G02B  <b>Databases (see over)</b> (i) UK Patent Office  (ii)	<b>Search Examiner</b>  MR C J ROSS  <b>Date of Search</b>  23.1.92
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Documents considered relevant following a search in respect of claims 1-9

Category (see over)	Identity of document and relevant passages	Relevant to claim(s)
X	US 4425026 (BAKER) see especially micrometer 46	1 at least
	US 4408832 (UTC)	1 at least
	US 4239343 (GDC)	1 at least
	US 4660941 (HATTORI)	1 at least

Category	Identity of document and relevant passages	Rélevant to claim(s)

### Categories of documents

**X:** Document indicating lack of novelty or of inventive step.

**Y:** Document indicating lack of inventive step if combined with one or more other documents of the same category.

**A:** Document indicating technological background and/or state of the art.

**P:** Document published on or after the declared priority date but before the filing date of the present application.

**E:** Patent document published on or after, but with priority date earlier than, the filing date of the present application.

**&:** Member of the same patent family, corresponding document.

**Databases:** The UK Patent Office database comprises classified collections of GB, EP, WO and US patent specifications as outlined periodically in the Official Journal (Patents). The on-line databases considered for search are also listed periodically in the Official Journal (Patents).